



EECS 270 Fall 2022

Introduction to Logic Design

1. Course Overview

What is this course about?

Basic methods and tools for the design of digital circuits.

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Electronic circuits whose inputs and outputs are only in one of two states:

- Low
- High

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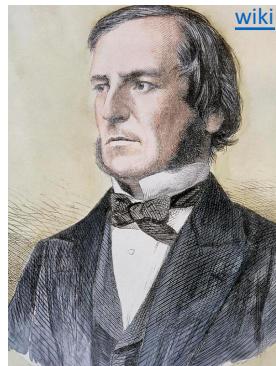
Basic methods and tools for the design of **digital circuits**.

Back in 1854 ...

The Laws of Thought

*annotated article can be found [here](#)

- Logic is math
- Boolean algebra:
the mathematics
of **binary** values



George Boole



Electronic circuits whose inputs and outputs
are only in one of two states:

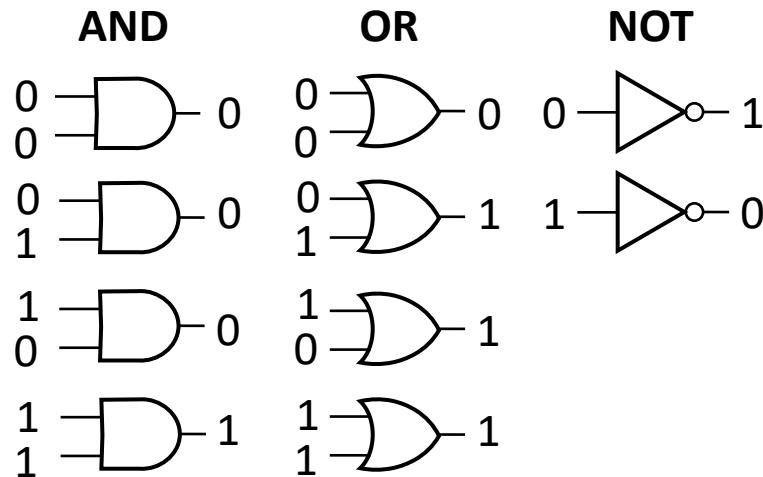
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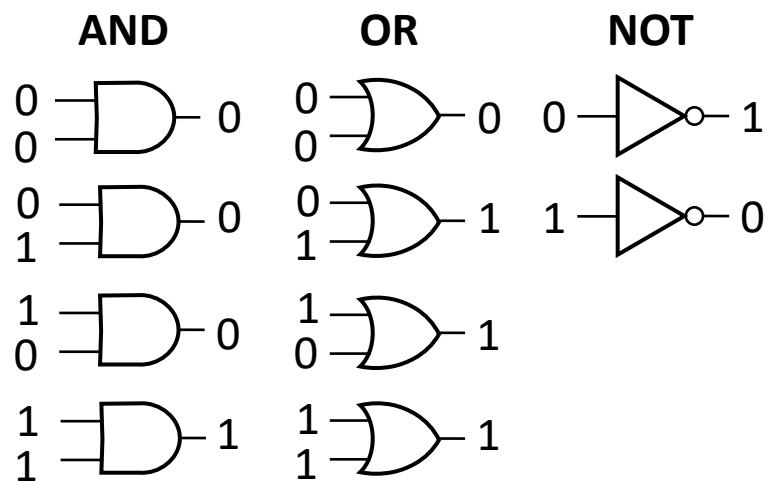
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What is this course about?

Basic methods and tools for the design of **digital circuits**.

Back in 1854 ...

The Laws of Thought



Electronic circuits whose inputs and outputs are only in one of two states:

- Low → 0 (False)
- High → 1 (True)

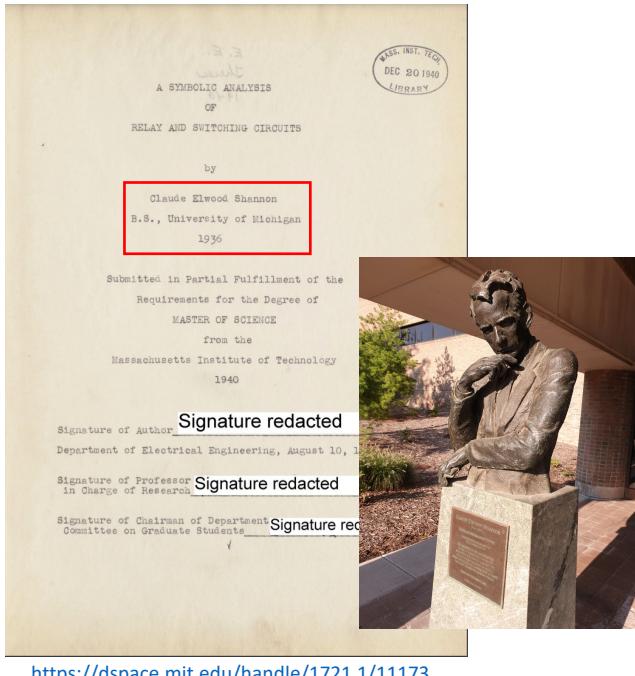
Binary interpretation

1938 ...

- Shannon notices similarities between Boolean algebra and electronic telephone switches

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Binary interpretation

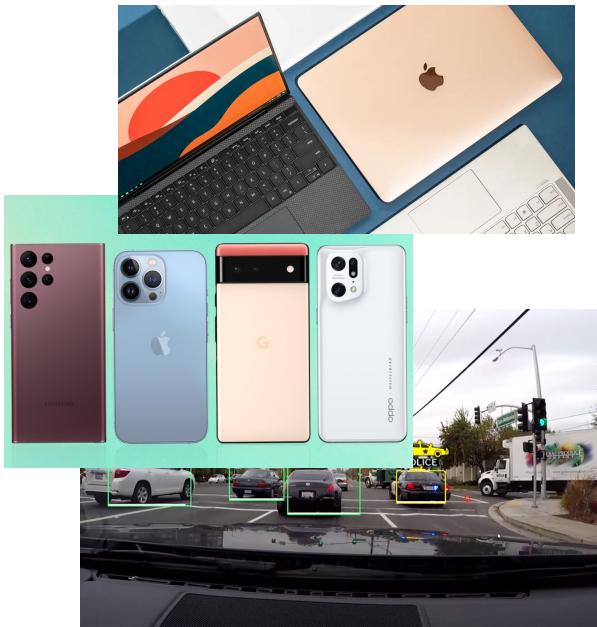
1938 ...

- Shannon notices similarities between Boolean algebra and electronic telephone switches
- Birth of digital circuit design

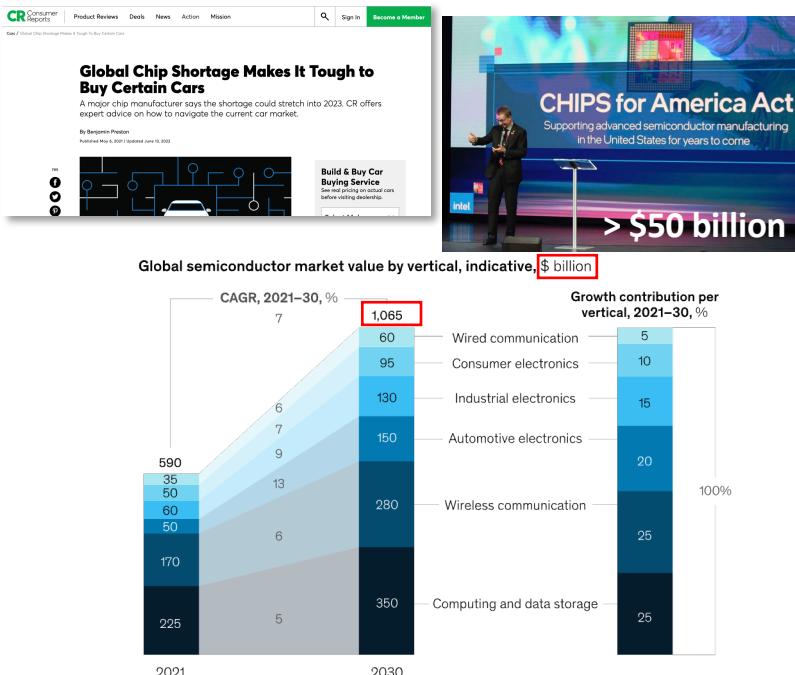
Why is this an important topic?

Software	
Application	
Algorithm	
Program	
OS & runtime	
ISA	
Architecture	
Digital Logic	
Logic Gates	
Circuit Cells	
Devices	
Technology	

Real Life



Economy



Courtesy: McKinsey & Company

Course objectives

- ❑ Learn the ``language'' of digital logic
- ❑ Learn how to design digital logic circuits
- ❑ Learn how to analyze digital logic circuits
- ❑ Learn how to construct, debug, and evaluate
real digital logic circuits

Course structure

- Lectures:** MW 10:30am-12:00pm @ 220 CHRYS
- Quizzes:** ~20
- Labs:** 1+8, 3 hrs/lab
- Exams:**
 - 2 x 2-hr midterms
 - 1 x 2-hr final

Course structure & grading

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100%

Lectures

Course Instructors

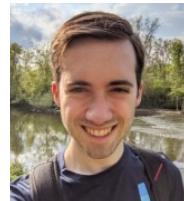


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Lecture GSI & IA



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Harrison Centner
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hcenter@umich.edu

Lectures

	Monday	Tuesday	Wednesday	
9:00am				Link to google form
10:00am			MCC w/ George @4777 BBB	
11:00am	Lecture @220 CHRYS	OH w/ Harrison virtual	Lecture @220 CHRYS	Revisit questions from last lecture
12:00pm				New material
1:00pm				Practice exercises
2:00pm	OH w/ George @4777 BBB		OH w/ Owen @BBB lobby	1-min survey
3:00pm				Quiz
4:00pm				

* [Piazza site](#) also available for questions

Lectures—Canvas

The screenshot shows a course schedule in Canvas. The left sidebar includes links for Account, Dashboard, Courses, Calendar, Inbox, History, Commons, Help, and a notifications icon. The main area displays a table with columns: Week, Date, Session, Topic, Quizzes, Lab, and Exceptions/Notes. The 'Topic' column is highlighted with a vertical orange border. An orange arrow points from the 'Quiz 1' link in week 1 to the 'Quiz 2' link in week 2.

Week	Date	Session	Topic (Click on Topic for Information and Lecture Video)	Quizzes	Lab	Exceptions/Notes
1	M Aug 29	1	Course Overview		Lab 0 Tutorial	
	W Aug 31	2	Bits Everywhere!	Quiz 1		
2	M Sep 5		Labor Day			No labs M Sep 5.
	W Sep 7	3	Timing and Delay	Quiz 2	Lab 1 (Combinational) Selector	
3	M Sep 12	4	Boolean Algebra	Quiz 3	Lab 2	
	W Sep 14	5	Switching Functions	Quiz 4	Timing	
4	M Sep 19	6	Positive Binary Numbers	Quiz 5		

Lectures—Canvas

The screenshot shows the University of Michigan Canvas interface for the EECS 270 001 Fall 2022 course. The left sidebar contains links for Account, Dashboard, Courses, Calendar, Inbox, History, Help, and Engineering Honor. The main content area displays the 'Session 1: Course Overview' page. The page includes a navigation bar with 'Last', 'Lecture Video' (highlighted with a yellow box), and 'Next'. Below this are sections for 'Topics' (Course Staff, Course Objectives, Readings, Assessment, Canvas Tour, Lab Tutorial) and 'Reading Assignment' (Lab Overview, Lab 0: Tutorial). At the bottom, there is a section for 'Older Lecture Video by Instructors' with a link to 'Lecture1-WN2022'. A large orange box highlights the 'Topics' section.

EECS 270 001 FA 2022 > Pages > Session 1: Course Overview

Fall 2022

Home Announcements Piazza

Last Lecture Video Next

Topics

- Course Staff
- Course Objectives
- Readings
- Assessment
- Canvas Tour
- Lab Tutorial

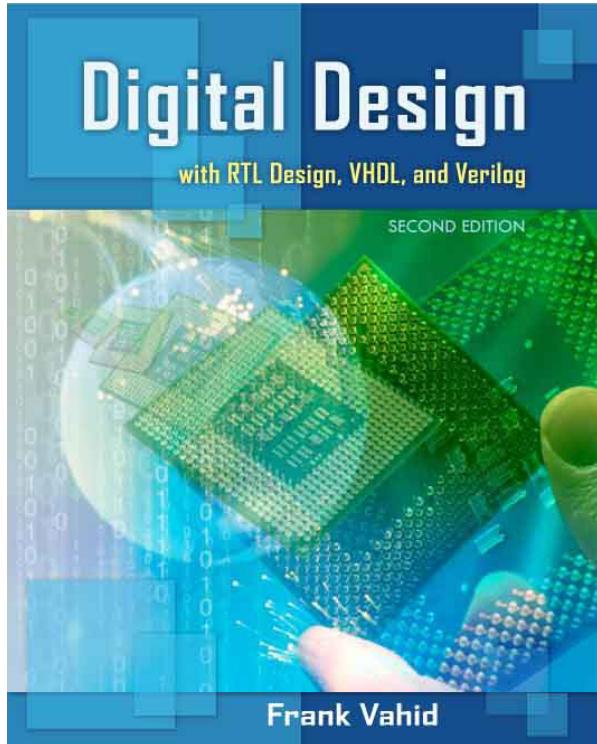
Reading Assignment

- [Lab Overview](#)
- [Lab 0: Tutorial](#)

Older Lecture Video by Instructors

- [Lecture1-WN2022](#)

Textbook (optional)



On reserve:

- F. Vahid, Digital Design with RTL Design, VHDL, and Verilog, 2nd ed., Wiley.
- J. F. Wakerly, Digital Design: Principles and Practices, 4th ed., Prentice-Hall.
- J. P. Hayes, Introduction to Digital Logic Design, Addison-Wesley.
- C. H. Roth, Jr., Fundamentals of Logic Design.
- R. H. Katz, Contemporary Logic Design, Prentice-Hall.
- D. Thomas, P. Moorby, The Verilog Hardware Description Language.

Quizzes

Motivation

- Help keep you engaged
- Provide quick drill on lecture material
- Collect immediate feedback

Structure & logistics

- 3-6 Canvas Quiz questions
- Quiz duration: 20 minutes
- 3 attempts, highest score kept
- Lowest 5 quiz scores dropped
- Open after lecture for 24 hours

Quizzes—Canvas

The screenshot shows a course schedule in Canvas. The left sidebar contains icons for Account, Dashboard, Courses, Calendar, Inbox, History, Commons, Help, and a notifications icon. The main area has a header with back, forward, and search buttons, and the URL umich.instructure.com/courses/549093. The schedule table has columns for Week, Date, Session, Topic, Quizzes, Lab, and Exceptions/Notes. An orange arrow points from the 'Quizzes' column to the 'Lab' column.

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- Exams:**
 - 2 x 2-hr midterms 40%
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100%

Labs

Lab Coordinator



Matthew Smith

3122 EECS

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Lab GSIs & IAs

Alexandru Beloiu

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Peter Linder

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Labs

- Lab #0: Tutorial
- Lab #1: Selector
- Lab #2: Timing analysis
- Lab #3: Robot control
- Lab #4: Calculator
- Lab #5: Up-down counter
- Lab #6: Traffic light controller
- Lab #7: Cash register
- Lab #8: Four-function calculator

Goal:

Problem statement/product specs

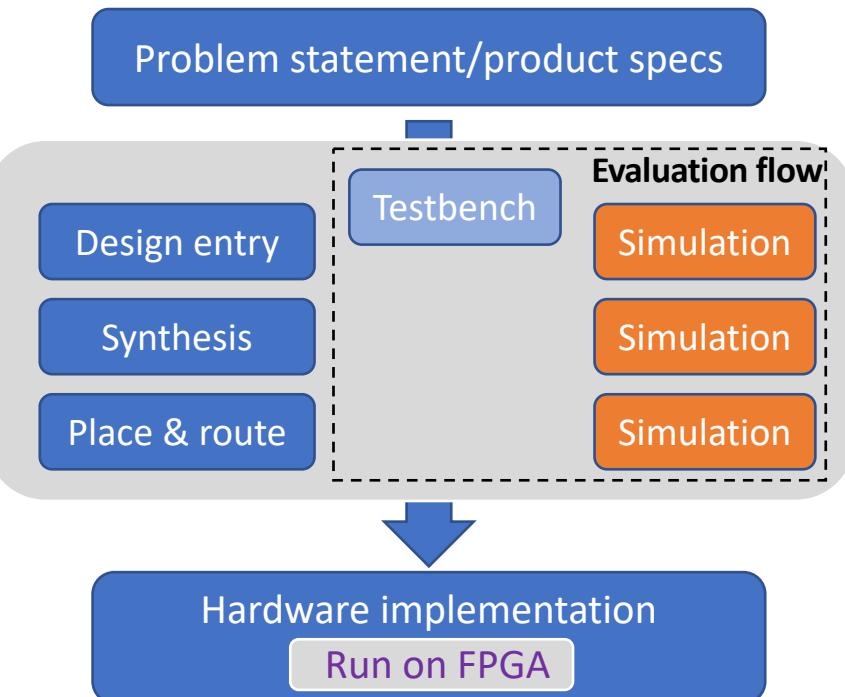


Hardware implementation

Labs

- Lab #0: Tutorial
- Lab #1: Selector
- Lab #2: Timing analysis
- Lab #3: Robot control
- Lab #4: Calculator
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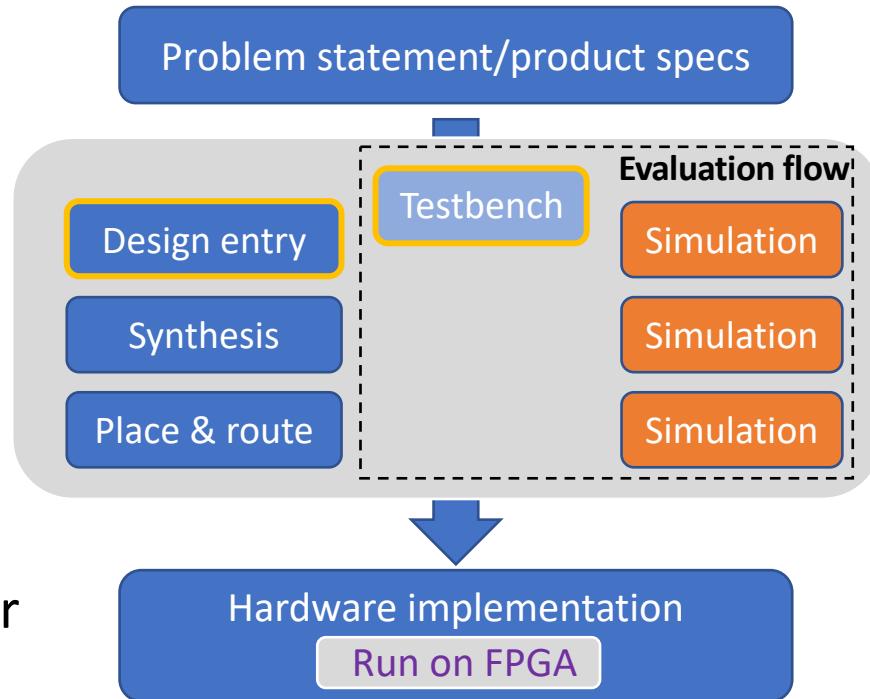
Goal:



Labs—how do we describe a digital circuit?

Goal:

- Lab #0: Tutorial
- Lab #1: Selector
- Lab #2: Timing analysis
- Lab #3: Robot control
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Labs—how do we describe a digital circuit?

With a hardware description language (HDL) 😊

Traditional HDLs

- Verilog
- VHDL

Verification + Logic

Functional HDLs

- Lava
- Hydra
- Clash
- Hawk

New HDLs

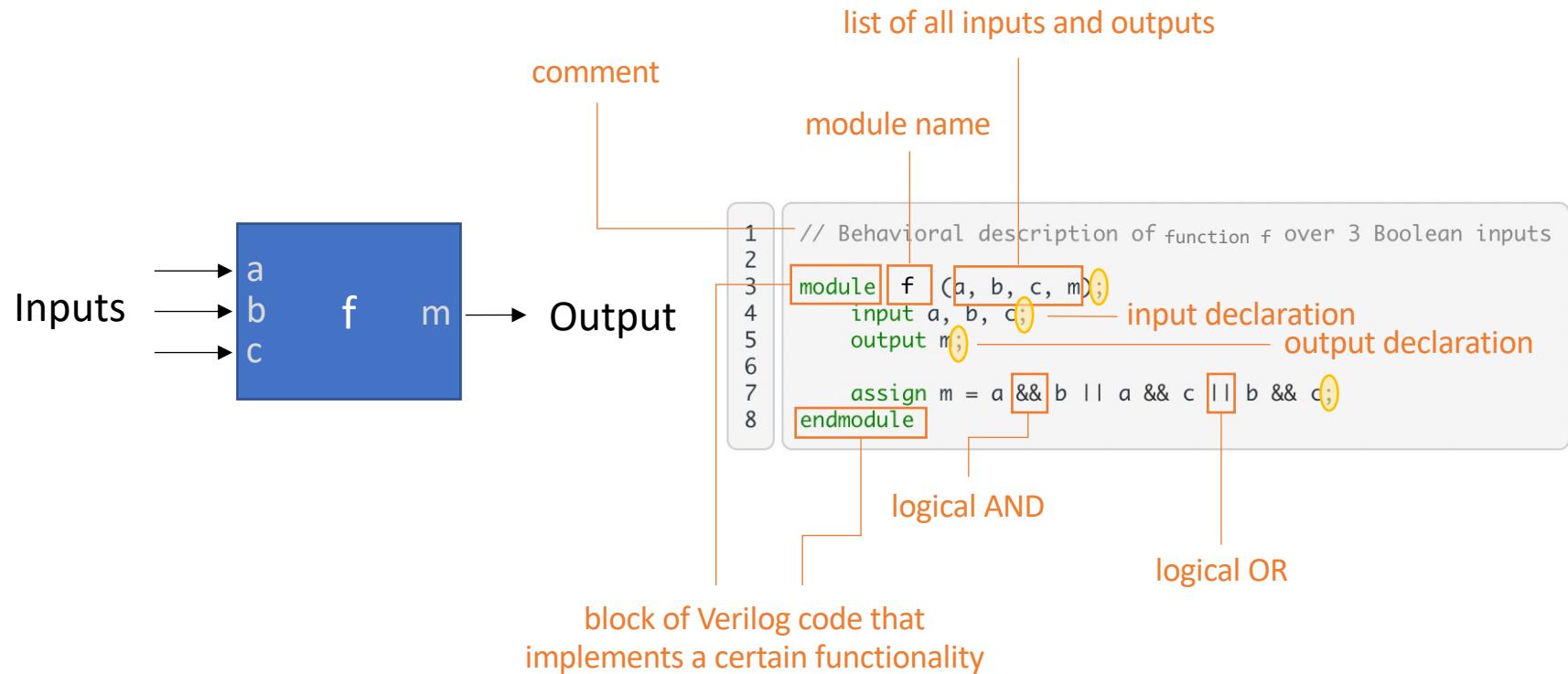
- PyRTL
- PyMTL
- Pyrope
- Chisel
- MyHDL
- TL-Verilog
- Migen
- nMigen
- SpinalHDL

High-Level Synthesis

- CHiMPS
- Hot-n-Spicy
- XLS
- Polyphony

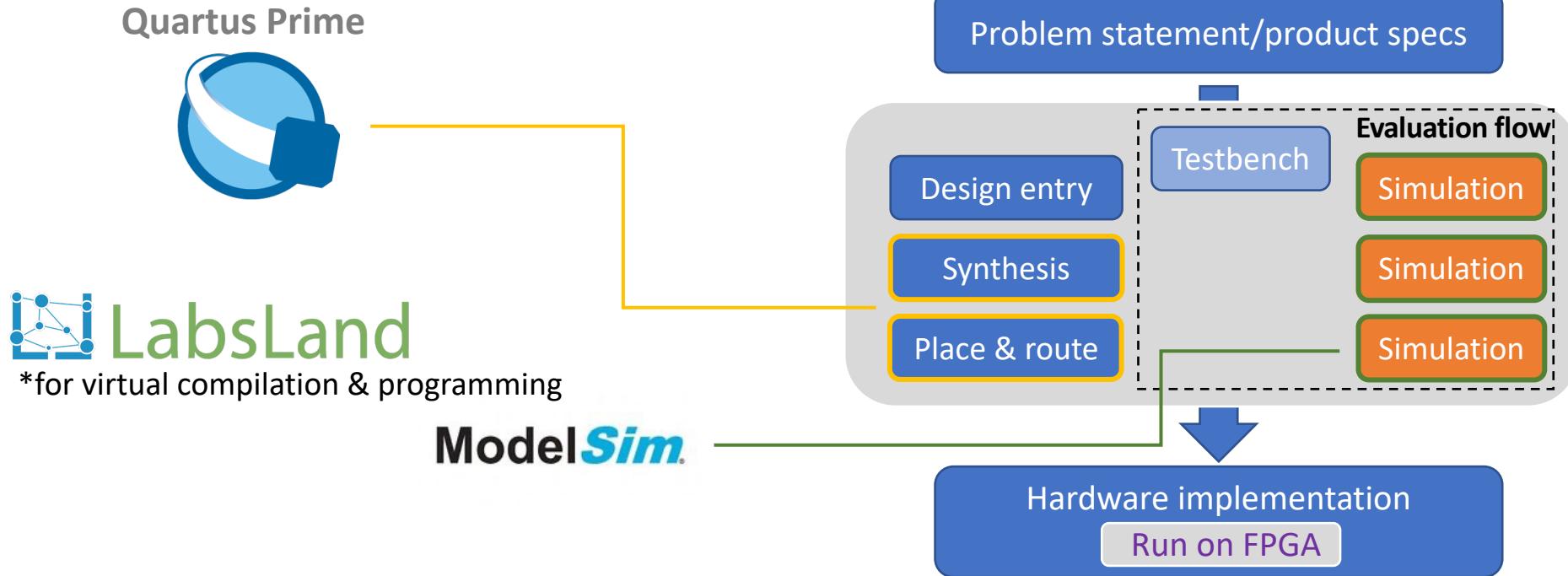
Active research area

Verilog—toy example



*additional online material ([Princeton](#), [UC Davis](#) ...)

Labs—tools



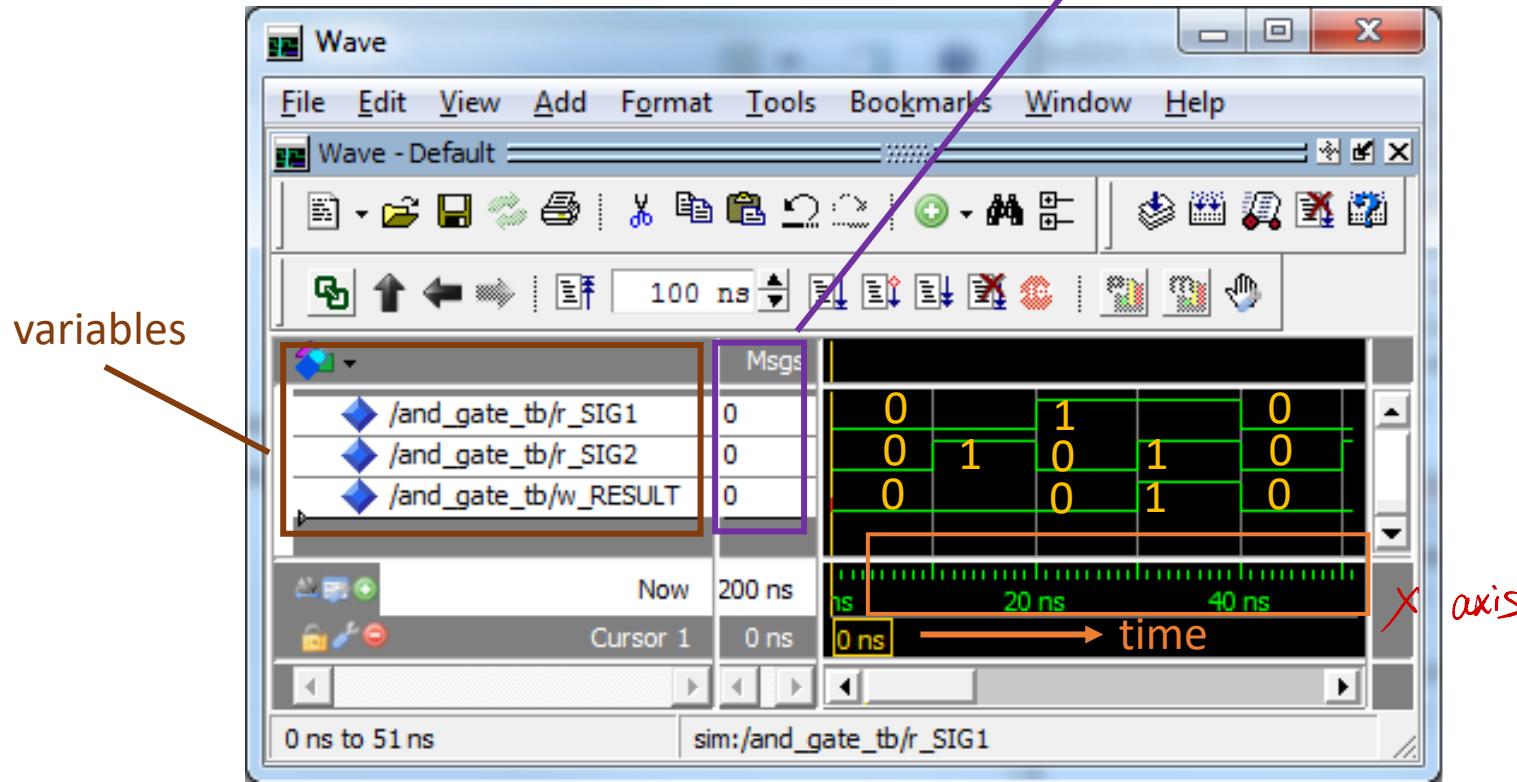
Labs—Canvas

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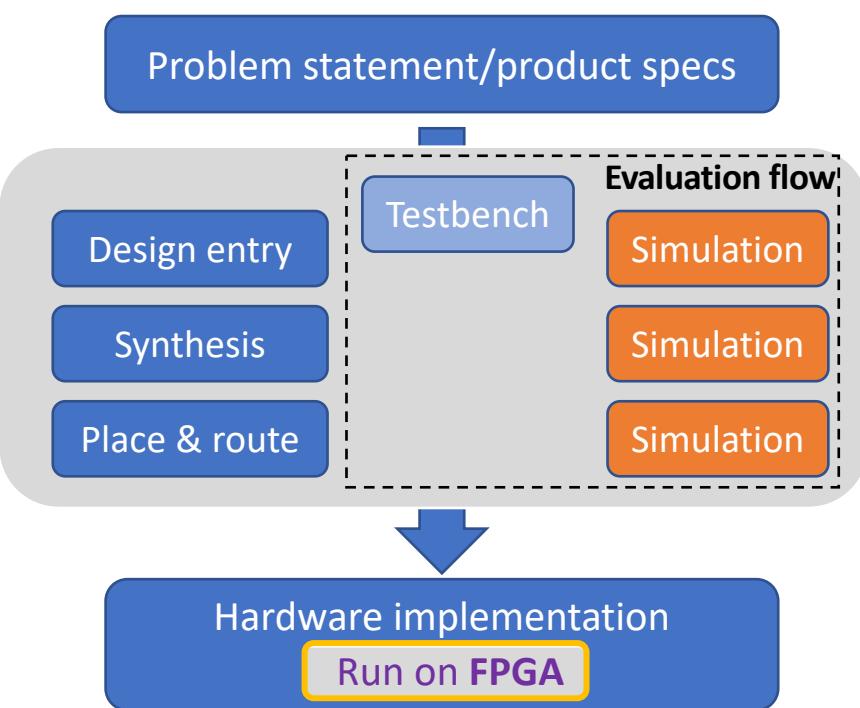
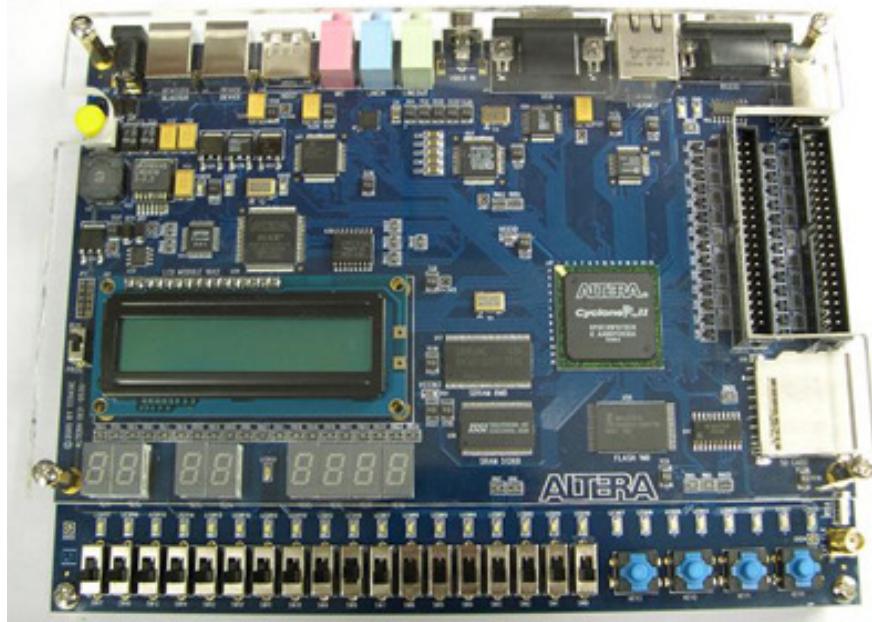
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An orange box highlights the "Lab" column for Week 1, and an orange arrow points from the right towards it.

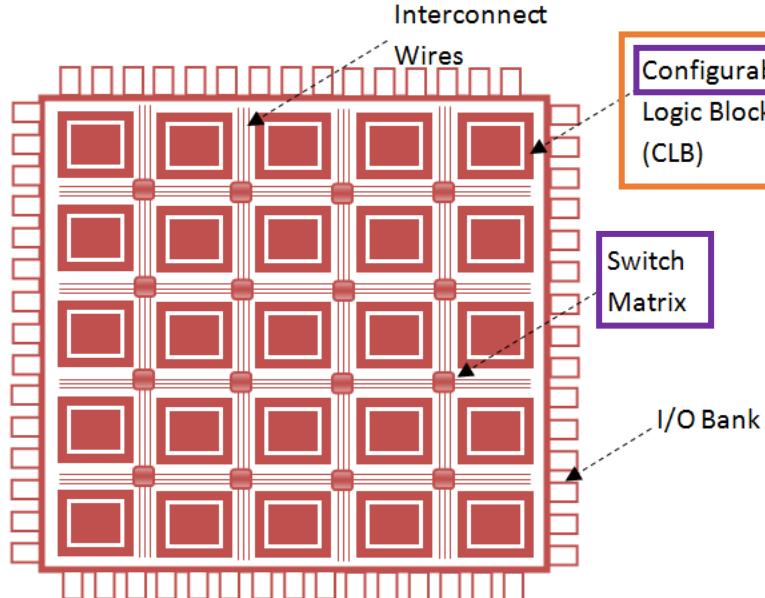
Labs—Waveforms



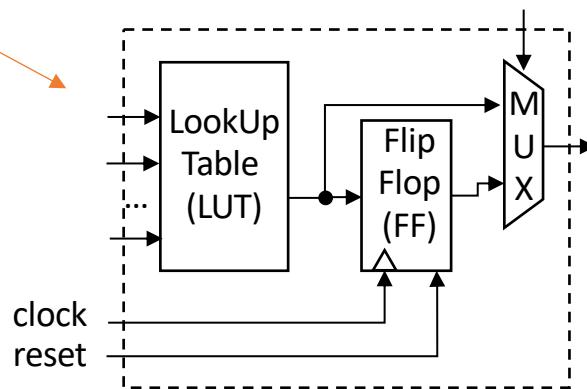
Labs—Field Programmable Gate Arrays



Labs—Field Programmable Gate Arrays



Simplified CLB architecture



Courtesy of www.allaboutfpga.com

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- | | |
|--|------|
| <input type="checkbox"/> Exams: | |
| <input type="checkbox"/> 2 x 2-hr midterms | 40% |
| <input type="checkbox"/> 1 x 2-hr final | 20% |
| | 100% |

Exams—important dates

Mon October 10, 6:00-8:00 PM

Midterm exam #1

Mon November 14, 6:00-8:00 PM

Midterm exam #2

Thu December 15, 4:00-6:00 PM

Final exam

Exams—policies

- No make-ups without valid documented excuse (and we've heard them all ☺)
- Coverage includes material from:**
 - Lectures
 - Reading assignments
 - Labs
- Closed book and notes except for:
 - One 8.5"x11" sheet of notes for midterm #1
 - Two 8.5"x11" sheets of notes for midterm #2
 - Three 8.5"x11" sheets of notes for final
- No electronics of any kind

Expectations

The **Honor Code** is based on these tenets:

- Engineers must possess **personal integrity** both as students and as professionals.
They must be honorable people to ensure safety, health, fairness, and the proper use of available resources in their undertakings.
- Members of the College of Engineering community are **honorable and trustworthy persons**.
- The students, faculty members, and administrators of the College of Engineering **trust** each other to uphold the principles of the Honor Code. They are jointly responsible for precautions against violations of its policies.
- It is dishonorable for students to receive credit for work that is not the result of their own efforts.**

*[link](#) to UofM's honor code

Expectations

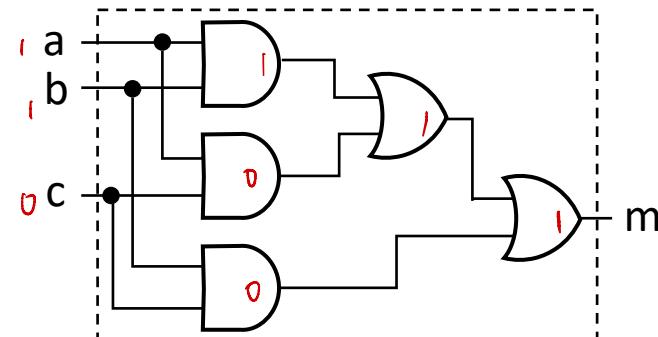
Teaching and lab staff are committed to maintaining a diverse, equitable, and inclusive environment.

Practice question of the day

Task: Describe function f.

```
1 // Behavioral description of function f over 3 Boolean inputs
2
3 module f (a, b, c, m);
4     input a, b, c;
5     output m;
6
7     assign m = a && b || a && c || b && c;
8 endmodule
```

Gate-level schematic of f:



Reminder:

	AND	OR	
0	0	0	//False
0	0	1	//True
1	1	1	
0	0	1	
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Truth table of f:

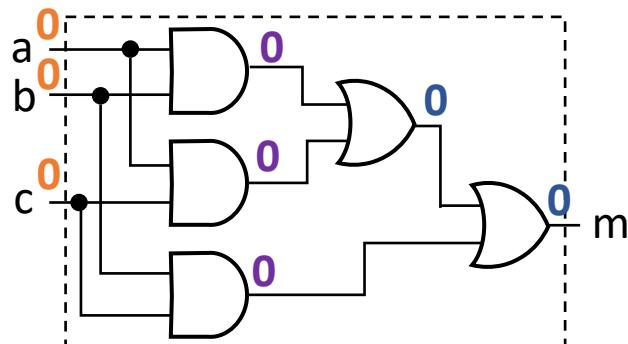
a	b	c	m
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

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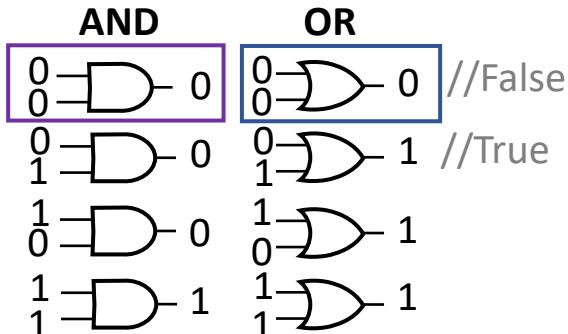
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Gate-level schematic of f:



Reminder:



Truth table of f:

a	b	c	m
0	0	0	0
0	0	1	
0	1	0	
0	1	1	1
1	0	0	
1	0	1	1
1	1	0	
1	1	1	1

Questions?